The presented methodological complex for studying Quaternary deposits of large lakes in key areas in our opinion can serve as a kind of standard for paleoliminological research. It allows us to cover with great clarity the main features of the structure of the cover of unconsolidated deposits, dismember it to stratigraphic and genetic subdivisions, give their lithologic and biostratigraphic characteristic. Further development of the presented methodology is associated with the introduction of new research methods. In particular, the use of ocean bottom nodes in conjunction with the continuous seismo-acoustic profiling will allow to construct the depth-velocity model of the medium (Vp, Vs) from the data of reflected, refracted, surface and converted waves. Hence this will allow us to perform seismic migration, improve the reliability of data interpretation and to try predict the physical properties of rocks.

This work was supported by grants from the St. Petersburg State University No. 18.42.1258.2014, 18.42.1488.2015, 0.42.956.2016 (for field research) and No. 18.40.68.2017 (for purchase of scientific equipment), grant from the Russian Foundation for Basic Research (RFBR) No. 18-05-00303, and the FEEL foundation, "Life Under the Ice project" (http://wiki.epfl.ch/ladoga) and projects of the Russian Science Foundation (RSF) No. 16-17-10076 and 14-17-00766.

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USAGE OF NEW SEISMOACOUSTIC METHODS FOR PALEOLYMNOLOGICAL STUDY OF THE LADOGA AND ONEGA LAKES

Rybalko A.E.[1,2], Tokarev M.Yu.[3], Subetto D.A.,[4] Aleshin M.I.[3,5], Beljaev P.Yu.[6]

[1]Institute of Earth Sciences of St.Petersburg State University, St.Petersburg, Russia,
[2]Ltd "Center for Analysis of Seismic Data at Moscow State University named MV Lomonosov", Moscow, Russia,
[3]Lomonosov Moscow State University, Moscow, Russia,
[4] Herzen State Pedagogical University, St.Petersburg, Russia
[5]Split Science Company, Moscow, Russia,
[6] A.P. Karpinsky Russian Geological Research Institute (VSEGEI) St.Petersburg, Russia.

Regional paleolimnological reconstruction of lakes and restoration of paleogeographic evolution of regions on the basis of the received results are getting more and more widespread recently. Tracing the spatial position of stratigraphic - genetic complexes, assessment the thickness of deposits, revealing characteristic of bottom relief reflecting the gradual development of paleobasins are important factors in these studies. In the conditions of lake basins, this function is currently performed by geophysical, mainly seismoacoustic, methods. Similar studies in both the largest lakes of the North-West of Russia after 2000 were carried out only sporadically. They was stopped after 2005. A new stage of seismoacoustic research was launched in 2014 as part of a joint program of three organizations: the Institute of Earth Sciences of St.Petersburg State University, the Institute of Water Problems of the North of the Karelian Center of the RAS and of the Center for Marine Studies of the Moscow State University. A distinctive feature of these works was the use of a new generation of high-frequency seismoacoustic equipment, which allows for multi-channel profiling. This made it possible to carry out a more detailed subdivision of the upper part of the section and obtain new data on the structure of the supraglacial deposits, and also on the nature of the manifestation of modern geodynamic movements. In 2014, works were carried out on Lake Ladoga, in 2015 - on Ladoga and Onega lakes, and in 2016 -

only on Lake Onega. NIS “Ecolog” and NIS “Professor Zenkevich” were the main research vessel of the expedition.

In 2014, very high resolution seismic (VHRS) with “boomer” source was used for detailed subdivision of the quaternary section (up to 0.3-0.5 m). Hardware parameters: energy source CSP-P Applied Acoustic with working voltage 2500V, working power 50-350J, electrodynamic energy source “Boomer” type with central frequency of signal 1700 Hz, seismic 16-channel streamer with 2 meter hydrophone step, navigation equipment - Trimble DSM132.

In 2015, a VHRS was used with “sparker” surce placed in a container with salt water. The following parameters were selected: the signal source energy is 400 J; working voltage - 3 kV; number of electrodes - 60; the central frequency of the radiation is 700 Hz. In 2016 the works were carried out mainly with the use of the Sparker source. The geophysical complex also included a side-scan locator. The work was carried out through a network of regional profiles with condensation of network of observations in interesting areas.

In Ladoga Lake, the main attention was paid to the study of the ratio of the of Riphean sandstones and Vendian argellites in the southern part of the lake, the assessment of the distribution and types of glacial deposits, and the detection of modern geodynamic movements. So, in 2015, it was succeeded to track in detail the relation of cross-bedded sandstones of Riphean age with the angular age overlapped by the Vendian argillites, which are already part of the platform cover of the Russian plate. These data allow us to more accurately assess the position of the platform cover at the bottom of the lake basin, suggest that the Vendian power is not large and does not exceed the first tens of meters. The facts of dislocations of these sedimentary rocks were revealed. Primary stratification was broken, and individual laminas were broken. Probably, these are traces of the exaration activity of glaciers moving along the soft surface of the Vendian mudstone. In some cases, seismic dislocations also capture the surface of Riphean sandstones.

Particular attention was paid to tracking glacial deposits. The spread of moraine was discontinuous in Ladoga and Onega lakes. Along with complete absence of till on the lake bottom, ridge-like forms of reliea were noted. Most often they are associated with uplifts in the preglacial relief. Typical drumlino-shaped forms have been established in a northern part of the lake and in the Solovetsky archipelago region. The main accumulation of moraine material were observed from the southern side of the ridges, opposite from the direction moving of the glacials. In the core of these uplifts, crystalline rocks are exposed, most likely represented by diabases forming the sill of the Valaam archipelago.

Other form of accumulation of glacial deposits is a chain of small uplifts crossing the Ladoga Lake from the mouth of the River Burnaya to the eastern shore of the lake. As expected, these ridges are composed mainly of glacial material. However, often in the core of these ridges are protrusions of bedrock. Perhaps, a chain of such residual positive forms of relief indicate on the northern contours of the Vendian Sea. These ridges have an asymmetrical shape with a gentle north-west and steep southeast slopes. Their relative height can reach 20-50m. Sometimes the protuberances of the bedrock are represented by the rocks of the dike complex. Such dykes of diabase are common in the Solovetsky archipelago.

Glacial deposits are practically absent in the zone of development of the structural relief, in the northern part of the lake. However, a similar pattern is typical for crystal ridges that form the basis of the structural relief of the Ladoga skerries. Thus, seismoacoustic works has made it possible to clarify the position of glacial complexes in the Ladoga Lake.

The carried out geophysical studies, accompanied by an interpretive sampling in the open part of the Onega Lake, made it possible to significantly refine the contours of the geological map of Quaternary sediments. The map of Quaternary sediments in present time composed mainly of date of small sampling (think cores up to 1 m and a significant limitation of the possibility of selection of glacial-lacustrine clays), has been substantially corrected by seismic profiling data and interpretation sampling. It has turned out that the Onega Transgression, as a result of which the Onega Basin actually formed, occurred under conditions of a relative deficit of detrital material. This did not allow the glacial muds of Holocene age to cover all irregularities of the pre-Holocene relief. As a result, the surface of the glacial-lake clay of the Late Neoplestocene was more widely represented at the bottom of the lake. Accordingly, the underwater landscapes developed on the leveled abrasion surface at depths of 30-40 m are represented by clayey sands and sandy silt with inclusion of crushed stone and semi-crocked pebbles of crystalline rocks.

In Lake Ladoga it was succeeded to specify significantly the structure of transect of glacial-lacustrine clays. The till is covered directly by a series of sediments with an obscure subhorizontal stratification, which is completely lost in places due to the appearance of a diffuse record. They occur in negative valley-like forms of relief. Perhaps these are deposits of fluvioglacial streams alternating with deposits of intraglacial lakes with layered texture. The thickness of supraglacial sediments is 17-20 meters. Above lies a pattern criptostratified sediments of thickness up to 12-15 meters. The sediments itself, judging from the texture, is homogeneous and very fine-grained by results to the granulometric composition. It is these deposits that carry out the upper part of the paleovalleys. Overlays these paleovalleys and lies on the moraine surface of a pattern of glacial-lacustrine clays with a clearly subhorizontal layering. Its thickness is 8-10 meters. Thus, one can imagine the following order of formation of the paleolakes. At the first stage, streams of melt water emerged from the front of the retreating glacier, and when changing their direction in the depressions, small lakes appeared where normal sedimentationof sandy sediments was already occurring. Further melting and retreat of the glacier has already led to the formation of large glacial lakes where conventional warves have already accumulated.

Seismoacoustic studies have made a special contribution to the evaluation of the nature of geodynamic postglacial processes. Many researchers pointed to seismotectonic activity in this region in the Holocene (B. Assinovskaya, A. Lukashov, A. Nikonov and others). The performed studies were able to confirm these assumptions. This is particularly evident in the northern part of the lake, where the shore is dissected by deep bays, and numerous islands form a skerry-like landscape. The northern basin of the Ladoga Lake has a very complicated relief with numerous underwater ridges separating isolated deep-water basins. Some of these structural ridges have a direct continuation on land, sharing separate fiards. The height of these ridges can reach 80-100 and more meters. Sometimes, the discontinuity of the uniform horizons stand out in the lakustrine deposits of Holocene age which allows one to assume that tectonic movements occur in Holocene time. On the steep slopes of these trench, gravitational processes are actively developed, at the foot, there are observed accumulations of landslide masses.

Traces of modern geodynamic movements are noted also in other places of Lake Ladoga. To the west of the island of Valaam, a tectonic disturbance dissects both the moraine ridge itself and the horisonts of the Holocene lacustrine sediments. Amplitudes of such displacements are up to 5 m, and the gliding plane is fairly hollow (up to 15 degrees).

These data confirm our opinion about the subsidence of blocks of crystalline rocks in the western part of the lake, which was accompanied by the "subsidence" of the strata of clays, their disturbation, up to the complete disappearance of structural elements of bedding. On the slopes of the trench, located from the island of Konevets to Priozersk along the coast numerous landslides were previously identified. These data were confirmed in our works. At the same time, outflows of gas fluids in the form of pok-marks were detected on the eastern side of these trench. Thus, along with the degradation of glaciation, transgressive-regressive fluctuations in lake level, the geodynamic factor significantly influenced the formation of modern and paleolandscapes.

This work was supported by grants from the St. Petersburg State University No. 18.42.1258.2014, 18.42.1488.2015, 0.42.956.2016 (for field research) and No. 18.40.68.2017 (for purchase of scientific equipment), grant from the Russian Foundation for Basic Research (RFBR) No. 18-05-00303, and the FEEL foundation, "Life Under the Ice project" (http://wiki.epfl.ch/ladoga) and projects of the Russian Science Foundation (RSF) No. 16-17-10076 and 14-17-00766.

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NEW DATA ON THE RESULTS OF THE MOLOGA-SHEKSNA LOWLAND LAKES RESEARCH (VOLOGDA REGION, RUSSIA)

Sadokov D.O.[1, 2], Sapelko T.V.[3], Bobrov N.Y.[2], Terekhov A.V.[3]

[1]Darwin State Nature Biosphere Reserve, Cherepovets, Russia
[2]Saint-Petersburg State University, Saint-Petersburg, Russia
[3]Institute of Limnology RAS, Saint-Petersburg, Russia

Scandinavian ice sheet deglaciation is closely connected with forming and dynamics of the Glacial Lakes in Upper Valday period. Mologa-Sheksna Lake was one of the Largest Glacial Lakes on the north-west of East-European Plane with an approximate area 23 282,84 km2 (calculated by the altitude of the lacustrine terrace 140-152 m) (Anisimov et al., 2016). The Mologa-Sheksna Lowland was covered by an ice sheet during Late-Pleistocene period, which reached it maximal boundaries approximately 19-18 thousand years ago, according to a range of radiocarbon and OSL dates (Hughes et al., 2016).

Most of the ice-margin relief patterns are poorly developed or even absent in the region which makes it difficult to specify the ice sheet true boundaries during the Last Glacial Maximum (LGM). Glacial sediments and moraines are overlaid by lake and lake-glacial sediments, and the material could have been distributed by floating ice masses (Kvasov, 1975). According to most prominent reconstructions. A variety of glacial landforms are found on the north of the Mologa-Sheksna Lowland (including the Mologa-Suda Lowland), and here on this basis several zones can be distinguished: an interior (proximal) zoneand also an exterior (distal) zone (Mokrienko et al., 1976), where the lakes Beloye and Pogoskoye are situated (Fig.1).

Lowland, according to the literature and geomorphological data and also on the open remote sensing materials. The main objective of the survey was to work out a characteristic of spatial and temporal margins of the Mologa-Sheksna Lake, especially about the time of its termination as a Glacial Lake. Another objective was to record the beginning of the Mologa-Sheksna Lake gradual regression. The locations of the sampling were chosen on the necessity to identify the Mologa-Sheksna lake's spatial boundaries, particularly in conditions of the glacial relief of the Lowland's north. Kvasov (1975) draws the Glacial Lake boundaries in its maximum by the isohypse 145 m; Anisimov et al. (2016) in this way take the isohypse 152 m, Lake Pogoskoye (Vologda region, Belozersk destrict, N 59,697° E 36,853°, alt. 146,3 m) and Lake Beloye (Vologda region, Babaevo district, N 59,379° E 35,626°, alt. 150,5 m) were studied in order to investigate the northern periphery of the lake (which probably was covered with floating ice here at certain time period). Also the Lake Hotavets (Vologda region, Cherepovets district, N 58,568° E 37,603°, alt. 102,4 m) was studied for interpolation the data from the central part of the Lowland and making a correct palaeogeographical reconstruction. All the three lakes are drainless mire relict lakes, and notable for their small depth (100-175 cm of water over the upper gyttja layer).

First stage of the research was profile georadar (GPR) survey of the lacustrine sediments which took place on early March, 2018. The survey was conducted using the "OKO-2" instrument with 150 MHz (shielded) and 50 MHz (unshielded) antennas. The profiles were laid evenly on the ice-snow cover of the lakes in order to detect most applicable positions for core sampling. The software Geoscan32 was used for processing and analyzing radargrams.